

Do online exercises influence the score on the exam?

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INTRODUCTION

We want to investigate whether an online practising system for Calculus exercises influences the score obtained on the exam.

WHICH COURSE? WHICH STUDENTS?

We want to report on our investigations around the use of additional online exercises in the first phase Calculus course for Bachelor of Engineering: Architecture at KULeuven. The course is split into two parts: a 3 credit points part in the first semester and a 4 credit points part in the second semester. For your interest: the whole bachelor (3 phases) consists of 180 credit points. Both parts are organised in lectures for the whole group of students and exercises sessions in smaller groups of around 25 to 30 students.

The Calculus book [1] used offers an online practising system (MathXL or MyMathLab Global) with more than 2000 exercises specific to the book. The exercises cover a broad range of topics from revision of secondary school Mathematics (more than 800 exercises) via limits, continuity, differentiation and integration for functions of one variable and for functions of more variables to vector calculus, (power) series and methods for solving differential equations.

WHY ADDITIONAL ONLINE EXERCISES?

During the exercise sessions the students are supervised and guided while making exercises from the handbook. Is there need for more exercises?

The gap between secondary school Mathematics and a university Calculus course for engineers is quite large. An additional concern is that students graduate in June from secondary school and seem to have forgotten a lot by the end of September when they start at university. Therefore a revision at the beginning of the semester is useful. An online revision system with feedback features is flexible with respect to the different starting level of each individual student.

Also during the later part of the first semester and during the whole second semester additional online exercises are very useful, because students can make the exercises wherever and whenever they want. The feedback environment is always available.

PROPERTIES OF THE ONLINE SYSTEM

In the online system the instructor can select exercises and combine these into homeworks, quizzes or tests, that come available to the students at a certain moment and have a due date after which they are invisible to the students. Furthermore students can always make 'free' exercises following a Study Plan.

We only work with homeworks, no tests or quizzes, because the aim of using the online system is that the students perform a learning process. For each exercise the answer of the student is checked and with appropriate feedback, a wrong answer can be corrected twice.

Some useful features of the online practising system:

- a pseudo random number generator makes the exercises different for each student and each time they are requested
- 'help me solve this' and 'view an example' options offer help upon request
- there is a link to the paragraph in the handbook that covers the subject
- an exercise can be repeated as a 'similar exercise' so as to make sure that it is really understood or to continue until the correct answer is given
- it is possible to start working on a homework, postpone it for some time and then continue later

PRACTICAL USE

In order to motivate the students to train themselves with the system, in the first lecture the purposes and advantages of the online exercises are explained and a demo is given. Registration is straight forward and the system is user-friendly. Making the exercises is not compulsory, but strongly advised and possibly rewarded with a bonus point.

During the first two weeks 7 homeworks of each 20 revision exercises are offered. These homeworks have due dates approximately 2 weeks later to stimulate the students to start working from the beginning of the semester. During the first semester 11 more homeworks with 10 to 20 exercises about new topics become gradually available, each with a due date 2 to 3 weeks later. During the second semester there are 9 more homeworks.

In each semester there is a partial evaluation of Calculus after 8 or 9 weeks. For a better preparation for these partial evaluations the due dates of the homeworks are delayed, so that all homeworks are available again and can be redone if necessary. This way of working also offers the opportunity to complete partially made homeworks and catch up missed homeworks.

HOW MANY STUDENTS?

We have been using the online system for 4 years now. The number of students taking the Calculus course and the number of students registered in the online system are surveyed in *Table 1*.

Table 1. Number of students

Academic year	Students in course	Students registered
2009 - 2010	161	135
2010 - 2011	162	131
2011 - 2012	184	165
2012 - 2013	171	161

GRADES IN THE ONLINE SYSTEM

The online system contains a grade book that for each student records the score on each homework that was (partially) made and averages these scores into a final grade. Missing homeworks are not taken into account. Because we also want to measure the learning effort we export the data of the grade book 3 to 4 times per semester and compute a grade using a zero score for missing homeworks. Each grade is a natural number between 0 and 20.

COMPARING THE GRADES

The diagrams of *Fig. 1* and *Fig. 2* show the grades obtained for the online exercises versus the grades obtained on the exam for both semesters of the year 2011 – 2012, the last year for which all information is available at this moment. We made these diagrams also for the other years and they were similar. While reading the diagrams, keep in mind that both grades are available only if the student registered for the online exercises and participated in the exam (158 students in the first semester and 134 in the second semester).

grades for online exercises versus exam

(first semester 2011 - 2012)

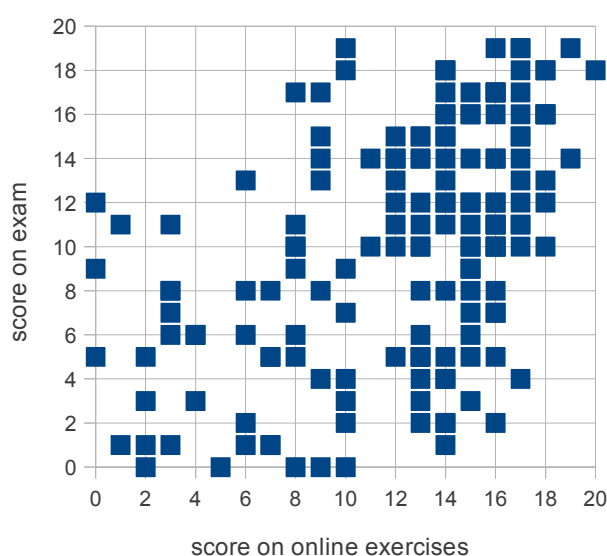


Fig. 1. Grades of the first semester of 2011 - 2012

grades for online exercises versus exam

(second semester 2011 - 2012)

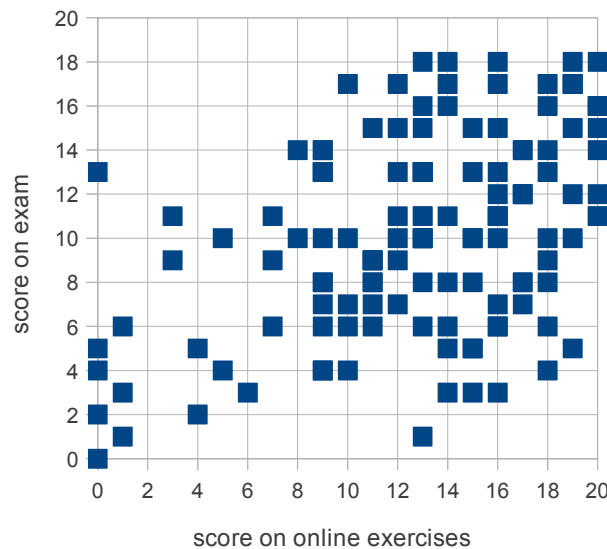


Fig. 2. Grades of the second semester of 2011 - 2012

Some remarks and conclusions:

- The scatter plots are very scattered. However, in both diagrams the top left corner is empty: a high grade for the exam does not match with a low grade for the online exercises. The bottom right corner shows the results of the hard working students that made a lot of exercises but did not succeed for the exam.
- 19 students did not register for the online exercises. 6 of them did not participate in the exam of the first semester, and of the 13 that did participate only 2 passed the exam successfully.
- The 7 students that registered for the online exercises but did not participate in the exam had very low grades for the exercises. Some of them made hardly any exercises.
- Much less students participated in the exam of the second semester. Most of these students had a low or very low grade for the exam of the first semester, and their grade for the online exercises is also very low. Probably they gave up this course. Some of them already left the program.
- Since we did not work with a control group that was not allowed to practise with the online system, we can not really prove that the online exercises influence the score on the exam.
- As a final conclusion we can say that a good grade on the online practising system seems a necessary but not sufficient condition for a good grade on the exam. Making the exercises helps but is not a guarantee for a good exam.
- And a final remark: Nowadays students can be better motivated for practising in an online environment than for making exercises with pencil and paper. And Calculus is a course that needs a lot of practising...

USE OF AN ENGLISH HANDBOOK

We also questioned the students about their experiences with an English handbook for these courses. As most students come from a secondary school where all courses are taught in Dutch, they need some time to get used to do Mathematics / Calculus in English. Most of them agree that after getting used to it, it is not really a problem. The best students even consider it as an advantage because it is preparation for future courses.

REFERENCES

- [1] Adams, R.A. and Essex C. (2009), Calculus, A Complete Course, seventh edition, Pearson Canada, Toronto.